deep sands with dense subsoils in Wilson, Atascosa and Gillespie counties; the Cottonwoods (*Populus balsamifera*) along the Llano and other open rivers of the Edwards Plateau and a low Palmetto in Kendall County northwest of San Antonio. A few hardy species, such as the Live Oak, Texas Oak, Hackberry, Southern Elm and White Ash (*Fraxinus texana*) were sufficiently adaptable or have undergone such modification in character that they have been able to survive, generally in a much reduced and stunted form, even in more open situations. But the most conclusive and striking evidence is afforded by those peculiar vestigial colonies of unmistakably Carolinian species, although most of them have been considerably modified by long isolation, found in the upper canyons of the Edwards Plateau. There, as the forest retreated before the increasing aridity of the region, they took refuge, and by reason of the protection afforded by the cliffs and the perennial water supply, which not only furnishes moisture for their roots but through its rapid evaporation keeps the air somewhat humid, they have been able to survive and stand as living witnesses to the mutations of time upon the flora of the region.

WEBB, CITY MISSOURI, *February*, 1920.

CAMPHOR

CINNAMOMUM CAMPHORA NEES & EBERMAIER

E. H. WILSON

IN the Occident camphor obtained from *Cinnamomum Camphora* Nees & Eberm. is the best known commercial product of Formosa and for this reason it is thought that information obtained during my recent visit to that island, where the industry is a Government monopoly, may be of interest. The tree grows in the warm-temperate and sub-tropical rain-forest zone of eastern Asia from south-central Japan to just within the borders of Tonking, yet for this variety of natural camphor the world is almost entirely dependent upon Formosa. In this island the tree is not to be found on the alluvial plains but in the submontane region from little above sea-level to 1400 m., being at its best between 500 and 1000 m. Within this altitudinal zone the Camphor-tree is found all over the island, but to-day apparently is most plentiful in the northeastern parts. It is never found in pure stands but always as an isolated tree scattered through the evergreen forests. These are mainly composed of other Lauraceae, evergreen Fagaceae and Tree Figs with a rich undergrowth of miscellaneous shrubs, Tree Ferns and coarse herbs; stout lianas abound and the tree-trunks and main branches are clothed with epiphytes, chiefly Ferns and Orchids. The country is steep and the Camphor-trees are tall but not really large, indeed, I saw none that merit special mention on account of size or approach that of many planted specimens in Japan. The finest I saw were on the east coast in Karenko and Giran prefectures. In Taihoku and in Nanto prefectures nearly all the accessible Camphor-trees have been felled.

In Japan the Camphor-tree is wild in southern Hondo, Shikoku and Kyu-

shu and as a planted tree is found as far north as Tokyo. It is a feature of the courtyards of temples dedicated to Hachiman, God of War. Many of these trees are of venerable age and of enormous size, in fact the Camphor-tree excedes in bulk of trunk all other broad-leaf trees that grow in Japan. On these planted trees burls develop on the trunk which with age becomes very gnarled and quite different in appearance to that of trees found in the forests. At the Hachiman shrine at Kamo in Satsuma province, Kyushu, there is a Camphor-tree 100 ft. tall and 75 ft. in girth of trunk at 5 ft. from the ground. It is claimed that this is the largest Camphor-tree in Japan. In the Shiroyama Park, Kagoshima, there are many tall and handsome specimens of this tree, but the finest I have seen are in the grounds of Osuwa Temple in Nagasaki which are lofty and magnificent trees with clean trunks and wide-spreading, rounded crowns. But in general the Camphor-tree in Japan is more remarkable for the size of its bole and spread of crown than for its height. On the Korean island of Quelpaert the Camphor-tree is indigenous but is rare and of no great size. In the eastern provinces of China from Shanghai south to the Tonking border the Camphor-tree grows wild and in some places is said to be common. In Japan and in Quelpaert the Camphor-tree does not ascend more than 500 m. above sea-level and is associated with other evergreen trees chiefly Fagaceae and Lauraceae. In China very little is known about its altitudinal distribution except that in the central parts of the Yangtsze Valley where it reaches its western limits it is more or less confined to river-level. The trees planted as far north as Tokyo are often subjected in winter to a few degrees of frost and to snowstorms which often brown the leaves but the trees quickly recover.

Small quantities of camphor are obtained in south Japan, in Fokien and Kwangtung provinces of China but the real industry is confined to Formosa. Apparently the climatic conditions there are more favorable to the secretion of the necessary hydro-carbons than elsewhere. It is a curious fact that not every Camphor-tree yields camphor in appreciable quantities, neither is every part of the tree equally rich. Often it happens that in two trees growing side by side one may be rich in camphor and the other almost devoid of it. Sometimes it happens that one side of the tree may be richer than the other. Why these marked variations in quantity should be there is no telling but the fact remains. Some day it may afford the plant hybridist opportunity to breed a race of Camphor-trees all equally rich in camphor. Chinese do most of the work of camphor distilling in the forests of Formosa, and they are expert in telling by means of smell and taste which trees are profitable to work and which are not. The bole of the tree is usually richest and frequently the thick, buttress roots rank next. The work of felling the tree is sometimes done in piecemeal fashion. The wood is reduced to thin chips by means of an adze or gouge-chisel and is then ready for camphor distillation. From the crude stills in the forest the camphor and camphor oil is taken to the factory of the Monopoly Bureau in Taihoku and refined.

To appreciate the difficulties of the camphor industry in Formosa it should be remembered that the mountains of Formosa are inhabited by savage tribes addicted to head-hunting. In late years the Japanese have succeeded in bringing many of these tribes under control; causing them to abandon their murderous practice. But the early story of camphor collecting is one of aggression on the part of the Chinese and retaliations by the savages with treachery and much bloodshed on both sides. Since the Japanese occupation it has been also a fruitful source of border warfare. At one time the whole area where the Camphor-tree grows was savage territory but little by little the Chinese with their camphor still, and latterly the Japanese, have penetrated and forced the savages farther and farther into the recesses of the higher mountains. The Chinese commenced the quest and the Japanese continue to systematically carry it forward. Nevertheless it will be many years yet before the whole Camphor-belt of the island becomes properly controlled. However, the tree is becoming rare, which should occasion no surprise when it is remembered that its destruction has been in progress since the sixteenth century and with increasing rapidity. Admitting that there are districts in which the Camphor-tree grows yet to be exploited it needs no prophet to foretell a shortage in the near future. The Japanese Government has realized the fact and commenced planting in the northern parts of Formosa on quite a large scale. I saw these plantations and they are thriving but there will be lean years before they are available as a source of supply.

The plantations are all pure which is contrary in method to what obtains in a state of nature, but in all the plantations I saw the young trees were growing well under those conditions. One point, however, must not be lost sight of. Fuel is necessary in camphor distilling and at present in Formosa is supplied by the companion trees of other kinds. In the plantations no such provision has been made so the fuel will have to be brought from a distance and the cost of camphor production will be increased.

There is another fact worthy of record which may have great or may have no effect on the yield from plantation camphor. In Formosa the wild Camphor-trees are tall and gathering the fruit has been found to be exceedingly difficult and costly. The Camphor Monopoly Bureau, therefore, has purchased and continues to purchase its stocks of Camphor-tree seeds in Japan where in temple grounds the gathering of the seed is a simple matter. So the situation is that plantation Camphor in Formosa, and for that matter everywhere else in the world, is the product of the Japanese Camphor-tree. Whether trees of this origin will produce camphor in quantity and quality comparable with that of the Formosan trees has yet to be proved.

The camphor industry of Formosa was established as a Government Monopoly in 1899 and the average annual production for the first decade, reckoning the Japanese kin as $1\frac{1}{3}$ lb. avoir., was camphor 4,375,886 lbs., camphor oil 3,757,269 lbs. In the previous decade (i.e. 1889–98) the average annual production of camphor was 4,219,199 lbs.; figures for camphor oil are not available. In the years 1895 and 1896 the produc-

tion of camphor was 6,877,297 lbs. and 6,935,285 lbs. respectively. In the fiscal year 1917 (the last return I have seen) the production of camphor is given as 7,371,574 lbs. and camphor oil as 6,727,512 lbs. These figures show that the industry has remained about stationary but the tendency now is toward a decline which must increase until plantation camphor becomes available. The quantity of camphor sold in the fiscal year 1917 is given as 9,308,960 lbs. valued at $3,466,150 gold; of camphor oil as 2,531,819 lbs. valued at $244,961 gold.

THE AMERICAN AND ASIATIC SPECIES OF SASSAFRAS

ALFRED REHDER

THE genus Sassafras stood for a long time as an example of a very distinct monotypic genus peculiar to the flora of eastern North America, until comparatively recently, in 1907, a Chinese species, *Sassafras tzumu*, was added to it by Hemsley. This Chinese species, though it is so similar in its general appearance, in its inflorescence and fruit that without close examination it is difficult to distinguish from the American *S. officinale*, differs in its floral structure in several important particulars, and for this reason was made by H. Lecomte the type of a distinct genus under the name Pseudosassafras. The chief differences are the hermaphrodite or apparently hermaphrodite flowers, the presence of a fourth staminal whorl consisting of three staminodes and the pubescence on the inside of the base of the perianth. Now a third closely related species appeared when Mr. Wilson, while arranging his extensive collection of the plants he brought back from Formosa, drew my attention to a plant described by Hayata as *Lindera randaiensis*, which looked almost exactly like the Chinese *Sassafras tzumu*. On closer examination this similarity extended even to the more minute structure of the flower except that the anthers had only 2 locules as correctly described by Hayata for his *Lindera randaiensis*, instead of 4, as a true Sassafras should have. The number of locules has been considered by most botanists who have dealt with Lauraceae a very important character, particularly by Pax who bases the main division of the whole family on this character; Bentham & Hooker, Lecomte and others lay much stress on this character, which, however, seems to lead to an artificial classification. Species with 2-loculed anthers may occur in genera with normally 4-loculed anthers, as in *Persea cuneata* Meissner; and in Persea § Heterandra the anthers of the third series of stamens have two locules, instead of the normal four of the first two series; the same is the case in Phoebe § Heteranthera. Also the reduction of hermaphrodite flowers to dioecious flowers does not necessitate generic separation, as we have both kinds of flowers in genera like Ocotea, Aydendron, Cinnamomum and others, nor does the absence or abortion of a staminodial whorl necessitate generic separation, as the presence or absence of staminodes varies in many genera. Instead of using the structure of the anthers whether introrse or extrorse, 4-celled or 2-celled, as the chief